From Fermi Arcs to the Nodal Metal

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Motivation

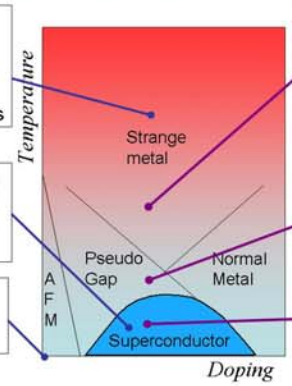
The high T_c superconductors

Of great interest, because their phase diagram exhibits the failure of three paradigms of 20th Century Solid State Physics!

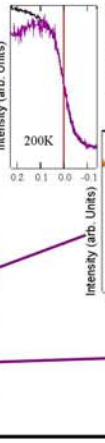
1) Landau's Fermi liquid theory fails for the strange metal and pseudogap regimes

2) BCS theory fails for Unconventional SC,particularly for x<<1

3) Band theory fails for the x=0 Parent insulator



Angle resolved photoemission view of the pseudogap

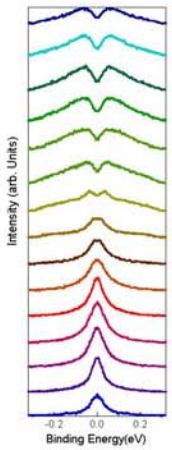


The "normal" state: At high T, the normal state is strange. There are no coherent excitations, i.e.no electrons, only collective excitations.

The pseudogap: As the temperature is lowered, a gap appears long before Superconductivity does.

Superconducting state: characterized by a gap, and sharp peaks in spectra due to coherent excitations.

The Fermi arcs: a most unusual state of matter: it is a metal, but its Fermi surface is broken up into disconnected segments



Part of the FS is gapped, i.e.the pseudogap

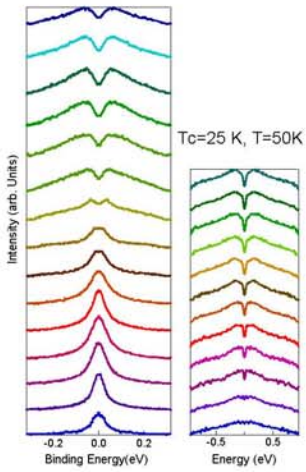
Part of the FS is gap-less i.e. there are Fermi arcs

Findings

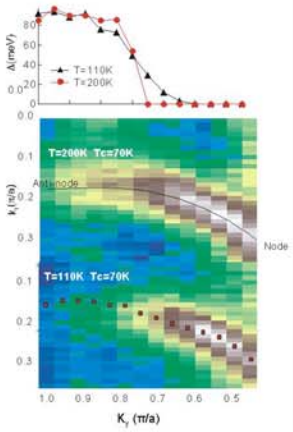
As the doping decreases, the Fermi arcs get shorter

Tc=90 K, T=140K

Tc=25 K, T=50K

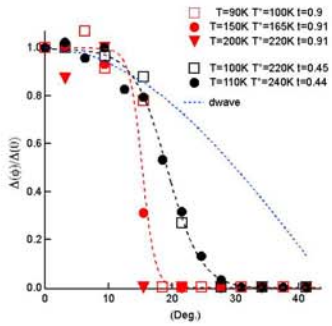


As the temperature decreases, the arcs also get shorter

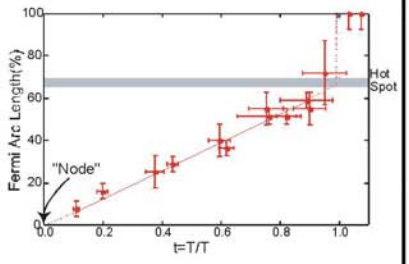


Scaling of the pseudogap $t = T/T^*(x)$

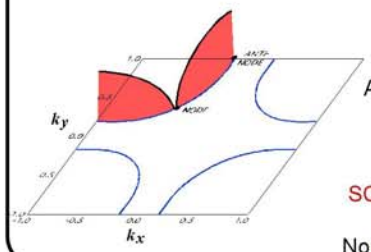
Scaling of the pseudogap vs angle around Fermi surface



Scaling of the Fermi arc length vs reduced temperature



Significance



The ground state of the pseudogap is a

"nodal metal"

A strange metallic state with only 4 gapless points

Can think of SC = PG + phase coherence

No competing order parameters

The future

- Measurements will be extended to a Tc = 0 sample
- A high energy beamline is being developed at the Advanced Photon Source to ensure that ARPES measures bulk properties

A. Kanigel, et al., Nature Physics, in press

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